Space Weather Technical Forecast

Issued on Thursday, 16 February 2023 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares (R1/R2 Radio Blackouts) likely, with a slight chance of isolated X-flares (R3 Radio Blackout). CME arrival forecast on 17 February, G1/Minor Storms likely with a chance of G2/Moderate Storms.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate, with four low-level M-class flares, all originating from AR3213 which has now rotated across the northwest limb, but which is still producing visible flares. AR3214, which is a complex region, but which is no longer visible, also has the capacity to produce significant flares. AR3226 is the most notable region on the visible disc, in the north centre disc, containing a small delta region. The remaining regions appear to be benign with no significant activity.

A CME which was observed leaving the vicinity of AR3220 early on 15 February, was analysed and is forecast to affect the Earth late on 17 February.

Solar Wind / Geomagnetic Activity: Solar wind speeds as observed at L1 have been on shallow declining trend from 350km/s to 325km/s through the period. Density started around or above average but declined to below average values as the Earth apparently moved through a CME sheath and post-sheath magnetic environment. Density has recently returned to average or slightly above average values. Total magnetic field is reflective of this analysis, with an increase from weak to moderate magnetic field strength at around 15/0430UTC, peaking at 13nT, then a further shock at 15/1030UTC on the transfer from the sheath into the magnetic cloud. The total magnetic field has continued at this level through the remainder of the period, before increasing to 15nT by the end of the period. The north-south component has been predominantly negative at around -10nT, with a rotation into a positive orientation at around 15/2120UTC, reaching a positive peak of +15nT by the end of the period. Phi angle started weakly positive (away from the Sun), then more strongly positive until around 15/1030UTC. The phi angle has been near neutral since that time. Geomagnetic activity has been Unsettled to Active, with one G1/Minor Storm period between 15/0600-0900UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at background levels. High energy electron flux (greater than 2MeV) at GOES16 has been at background levels throughout. Electron fluence values have been below the Active (1e8 integrated pfu) threshold throughout on a downward trend, reaching 1.31e6 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is forecast to be mainly Moderate, with a very slight chance of High activity due to X-class flares.

Solar Wind / Geomagnetic Activity: Earth is currently under the influence of a CME, with the effects of this likely to wane through 16 February. A further CME which left the Sun on 15 February is forecast to arrive at Earth later on 17 February. Effects from this CME are then likely to last at least through much of 18 February and perhaps into 19 February. No coronal hole high speed streams are forecast, although the CME arrival could lead to speeds of 400-500km/s. Geomagnetic activity is expected to decline to mainly Quiet to Unsettled levels on 16 February. G1/Minor storm periods and a risk of G2/Moderate storms are then possible on 17 February due to the CME arrival, with a reducing risk as the forecast period progresses.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, but with a slight chance of exceeding S1 in response to any significant flares. High energy (greater than 2 MeV) electron flux is expected to be at mostly background levels due to CME effects. The associated 24 hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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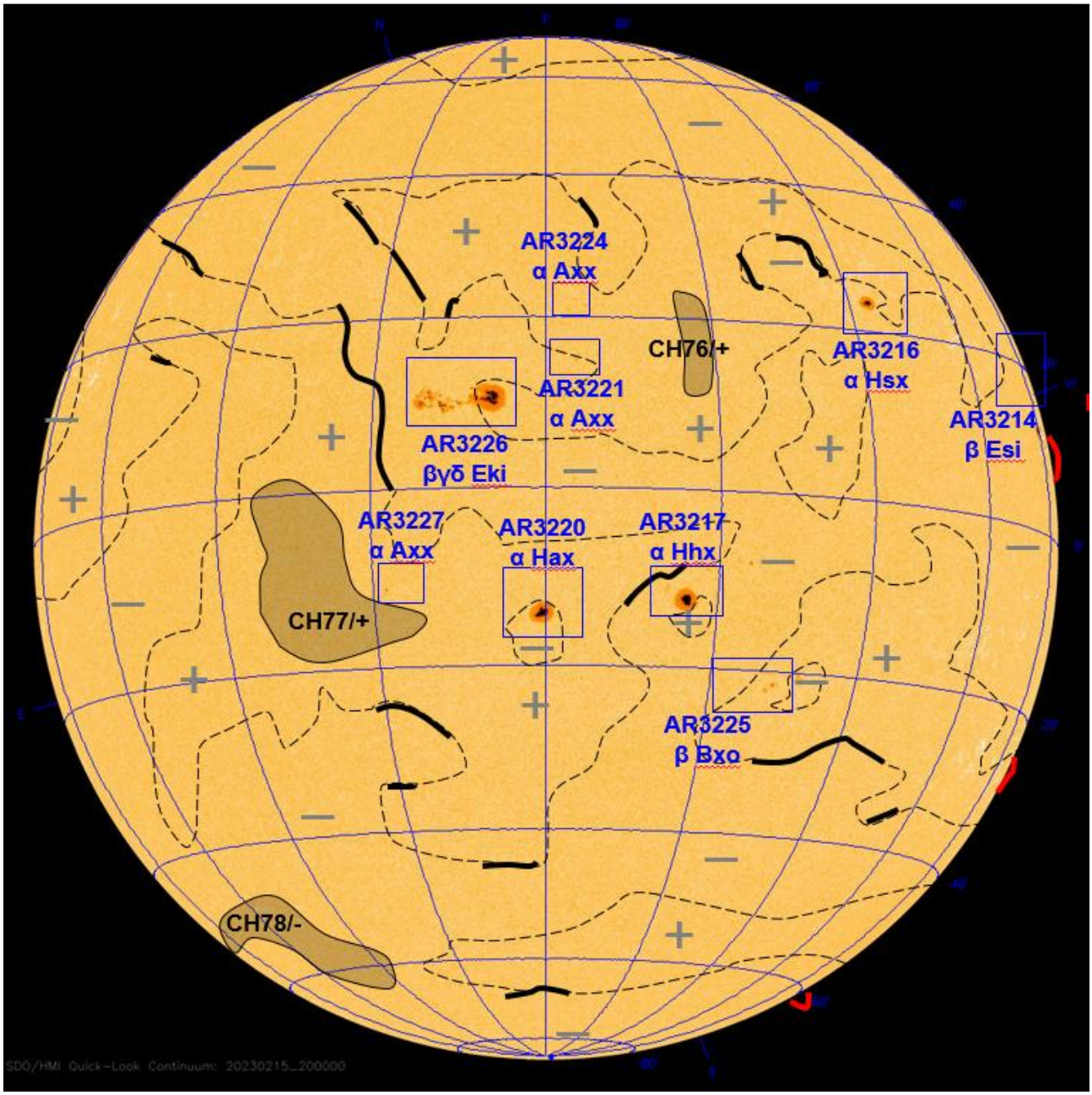
Figure 1. Solar Analysis Valid 17/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Earth is currently under the effects of a CME, with these likely to decline through 16 February. A further CME was seem emanating from the vicinity of AR3220 early on 15 February, with a forecast arrival most likely late on 17 February.

No coronal hole high speed streams are expected during the period, with no speed increases observed on fragmented STEREO A data. Persistence and Enlil are both indicating an increase in solar winds from 16 February, peaking at 600km/s on 17 February, but this is considered to be low probability given the STEREO A observations. There are also no distinct coronal holes in the western hemisphere, with coronal hole 76 in the northwest quadrant considered too weak to produce strong solar wind speeds. Speeds could however reach 400-500km/s following the arrival of the forecast CME on 17 February, with these then continuing into 18 February before declining.

Geomagnetic activity is forecast to be largely Quiet to Unsettled on 16 February, but with a slight chance of Active intervals at first. A risk of G1/Minor Storm intervals is forecast on 17 February due to the potential CME arrival, with a chance of G2/Moderate storms. A decline back to Quiet to Unsettled levels is then possible on 19 February.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	5	60	30	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/0815	Partial	Filament eruption	Close to AR3220	400-500km/s	17/1800UTC +/- 12 hours	Possible G1 or G2 storms

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Figure 2: Recent L1 solar wind observations

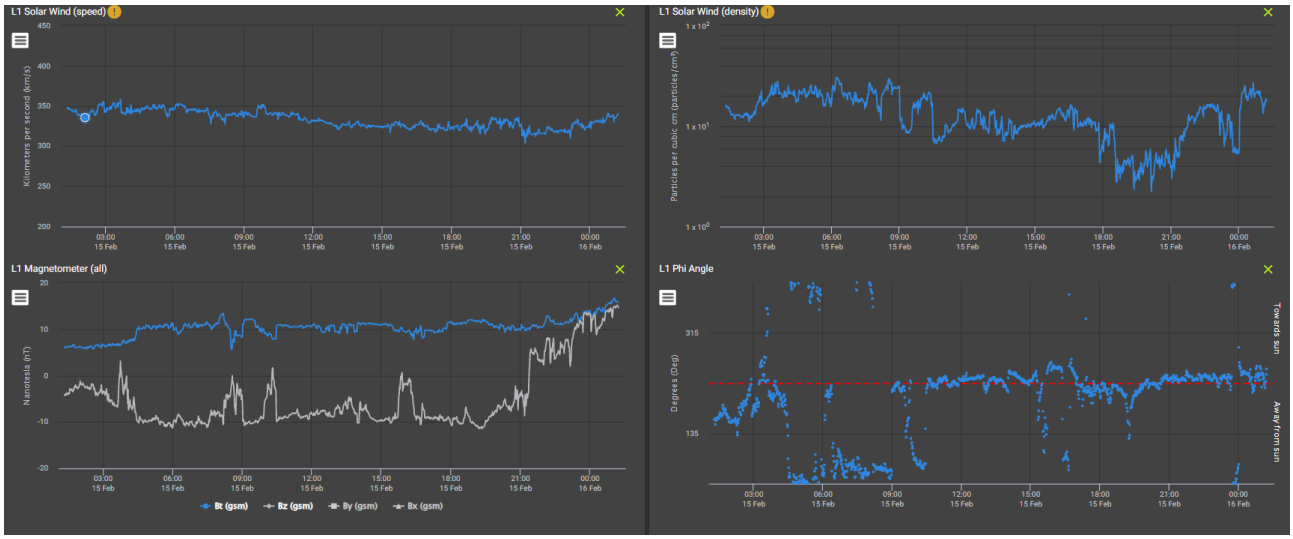
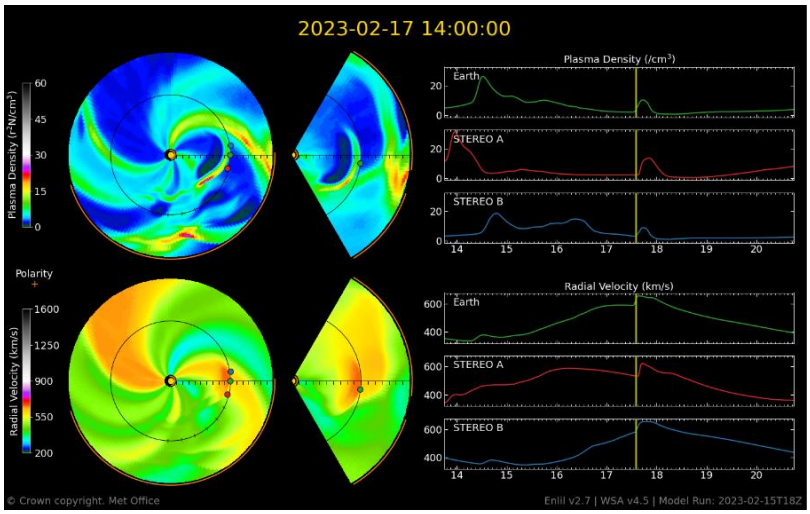
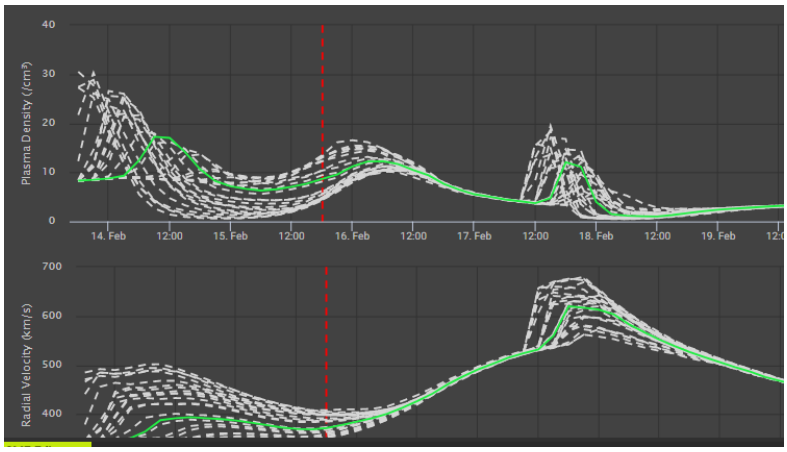


Figure 3: Enlil output at point of CME arrival and Enlil ensemble showing possible arrival time





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Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate and is expected to continue to Moderate levels, with a slight chance of X-class flaring. The main risk from significant flare activity appear to be two regions on or very close to the northwest limb, AR3213 and AR3214. Although these are moving across the limb, they still pose a risk from any flares elevated above the edge of the solar disc. AR3226 is the most significant region on the central part of the disc, just approaching north-centre disc. This is classified as an Eki/Beta-Gamma-Delta and has lengthened in the last 24 hours, although with little signs of notable activity. The remaining regions are all currently small and benign.
The risk of significant flares takes into account the regions moving off the western edge, those on the central disc and a chance of some returning regions rotating across the eastern horizon through the next four days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: GOES 18 X-ray flux

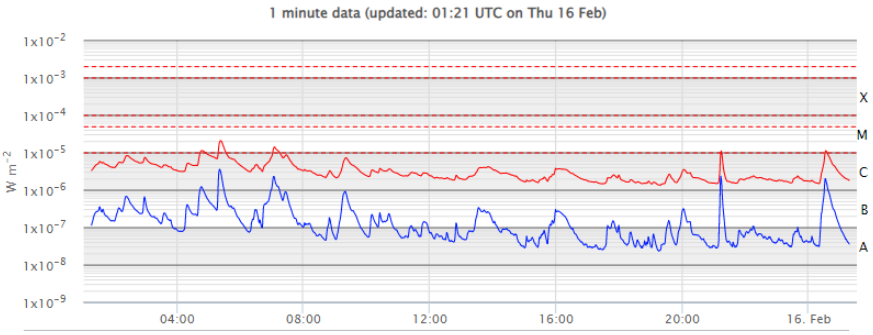
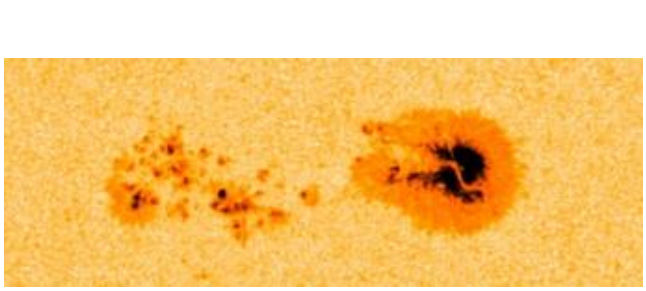
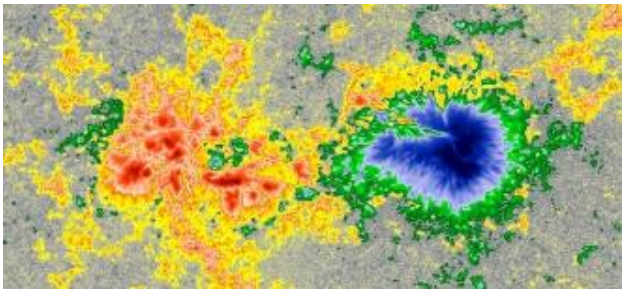


Figure 5: HMI intensitygram and magnetogram imagery of AR3226 (Eki/Beta-Gamma-Delta)





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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels.

No notable high energy proton response has been observed from recent M-flares. Any further significant flares may increase count rates, with a slight chance of exceeding the S1 level. AR3213 is currently rotating off the disc, with AR3214 soon following. AR3217 has decayed significantly in the last couple of days and is considered unlikely to present a significant risk of a proton event in its current configuration. This means that as AR3226 rotates westward it will maintain some risk of a proton enhancement, but this perhaps lower than in recent days.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) at GOES 16 has been at background levels throughout the period due to enhancements in geomagnetic activity, with modest solar wind speeds. Flux levels may increase once the current geomagnetic effects begin to wane, this is likely to be a short-lived increase, with the forecast effects of a CME from later on 16 and through 17 February perhaps suppressing electron values further. A slight recovery could then develop through 19 February.

Associated 24 hour fluence values are below the Active (1e8 integrated pfu) threshold on a downward trend. Although some increases in flux and consequently fluence are possible through the forecast period, these are unlikely to result in Active fluence levels.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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